DBE TECHNOLOGY NEWS

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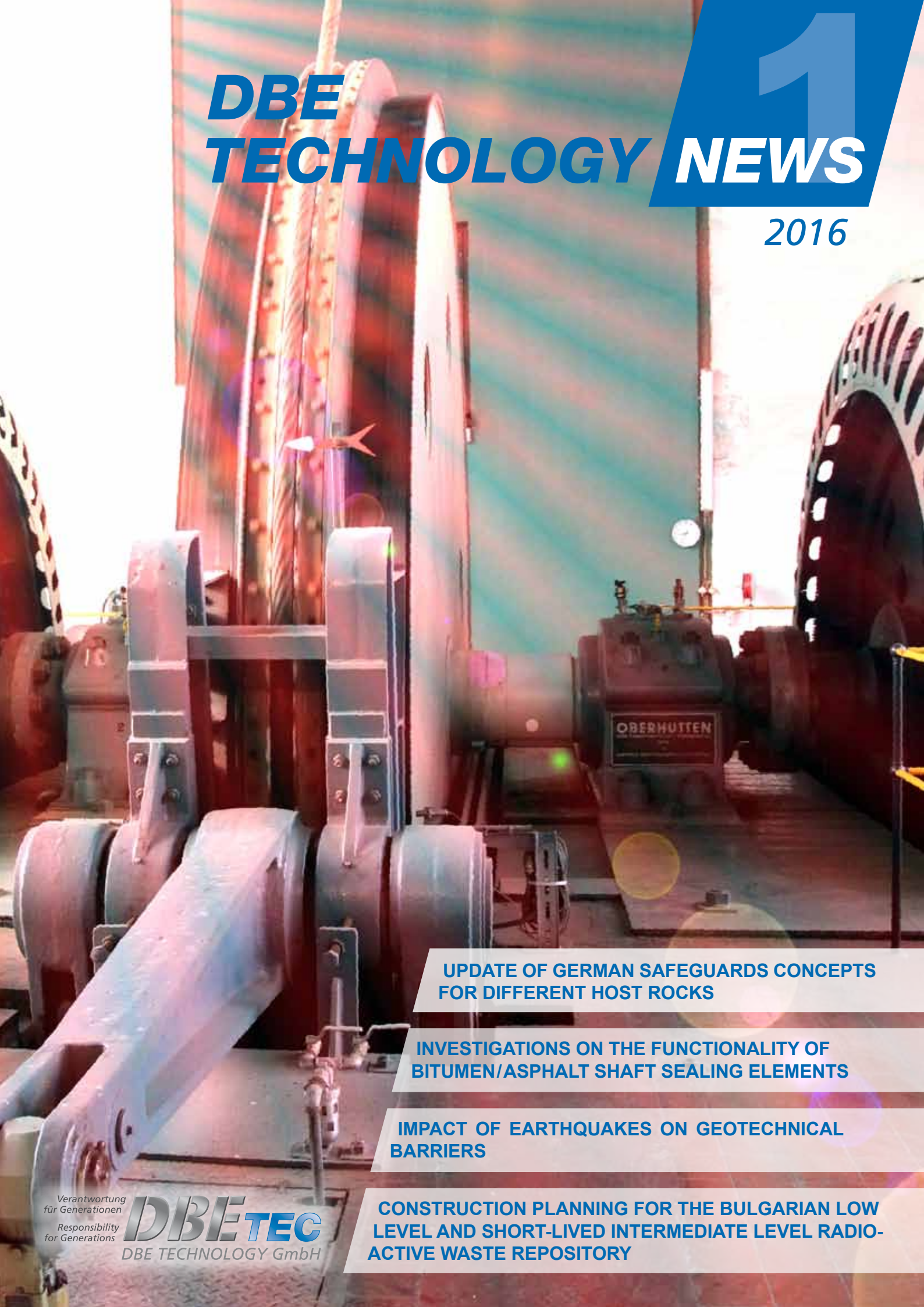

UPDATE OF GERMAN SAFEGUARDS CONCEPTS FOR DIFFERENT HOST ROCKS

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Verantwortung für Generationen
Responsibility for Generations

DBE TECHNOLOGY GmbH

IAEA Consultancy Meeting, Vienna, November, 2015 (3rd from right: W. Bollingerfehr, DBE TECHNOLOGY GmbH)

Dear Readers!

This leaflet again gives a brief overview of the most recent activities of our small engineering and consulting company that focuses on radioactive waste management and is located in a small town in the center of Northern Germany. This is the tenth issue of DBE TECHNOLOGY NEWS and the positive feedback to the earlier issues that we received from colleagues in Germany and abroad does not only encourage us in continuing to compile a company newsletter every three months but also makes our small team feel part of the international community that tackles one of the major scientific, technical and ethical challenges of our generation – sustainably safe disposal of radioactive waste.

At the end of last year we were very pleased to hear from our Finish colleagues of Posiva Oy that their national nuclear regulatory body, STUK, granted the license to construct the first geologic repository for spent nuclear fuel worldwide. This remarkable success of Posiva Oy is important evidence that spent nuclear fuel and other high-level radioactive waste can be disposed of safely in deep geologic formations and that corresponding facilities can be implemented within reasonable time frames. Suitable organization and a well-focused program for nuclear waste management at national level as well as clear commitment to safety and to not to shift undue burdens to future generations are major success factors.

In Germany, the commission on high-level radioactive waste disposal that was appointed by the German Parliament two years ago will have to issue its report by June 30, 2016. The report shall contain recommendations for implementing a scientifically sound and transparent procedure for selecting a site for the disposal of high-level radioactive waste. Due to the worldwide unique history of national controversies on radioactive waste disposal as the focus of the public debate on nuclear power in Germany, clear commitments to overcome these difficulties and to enable a successful implementation are expected. At the same time, activities for reorganizing the Federal Government's responsibility for radioactive waste disposal have been initiated in order to eliminate existing inefficiencies.

Our small team with its expertise and experience in radioactive waste disposal – in close cooperation with our colleagues from other German organizations and from abroad – is well prepared and committed to contribute to the success of these processes.

We look forward to continuing our fruitful cooperation and wish you a happy New Year, success, and personal welfare.

Happy reading!

Dr. Jürgen Krone

Managing Director
DBE TECHNOLOGY GmbH

DBE TECHNOLOGY GmbH

Update of German safeguards concepts for different host rocks

Due to its membership in the European Atomic Energy Community (EURATOM) and its signing of the Treaty on the Non-Proliferation of Nuclear Weapons, Germany is obliged to ensure that nuclear material will only be used for peaceful purposes. This will be accomplished with safeguards measures that will ensure that nuclear material will not be diverted for non-peaceful usage and that the basic technical characteristics of the facilities for the production, separation or other applications of nuclear material have to be verified.

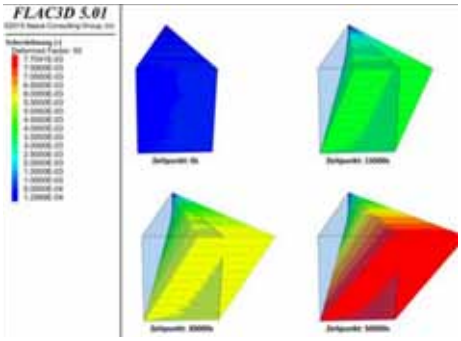
Spent nuclear fuel belongs to such nuclear material that has to be monitored for safeguards purposes. For this reason, the disposal concepts have to include safeguards measures. A concept for the safeguards in a repository in Germany was developed for the emplacement of POLLUX® casks in horizontal drifts in the host rock salt. At that time, retrieval of the POLLUX® casks was not considered. Since 2010, when the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety issued the safety requirements for the final disposal of heat-generating radioactive waste, retrieval of the casks during the operating phase of a repository and recovery of the casks 500 years after closure have to be considered.

In autumn 2014, Forschungszentrum Jülich on behalf of the Federal Ministry for Economic Affairs and Energy contracted DBE TECHNOLOGY GmbH with the R&D project FORBAS to update and refine the safeguards reference concept for the direct disposal of spent fuel for the host rocks salt, clay, and hard rock. Furthermore, the applicability of this concept to other emplacement concepts, e.g. the emplacement of transport and storage casks in horizontal boreholes, has to be considered. This will be based on analyses of safeguards developments for repository projects both nationally and internationally. In FORBAS, the impacts of retrievability and recovery of casks on the safeguards concept and resulting requirements will be analysed for the different emplacement concepts and host rocks.

Bitumen casting test for a shaft seal (Source: TU Freiberg)

Investigations on the functionality of bitumen/ asphalt shaft sealing elements

DBE TECHNOLOGY GmbH together with Technical University of Freiberg are developing shaft sealing concepts for repositories for high-level radioactive waste (R&D project ELSA, funded by the Project Management Agency Karlsruhe acting on behalf of the Federal Ministry for Economic Affairs and Energy). The goal of the project is to design shaft seals that are based on material investigations, site-specific boundary conditions, and the different safety concepts for salt and clay formations in Germany.



Shear deformation and shear strain inside the simulated part of the bitumen sample at different times

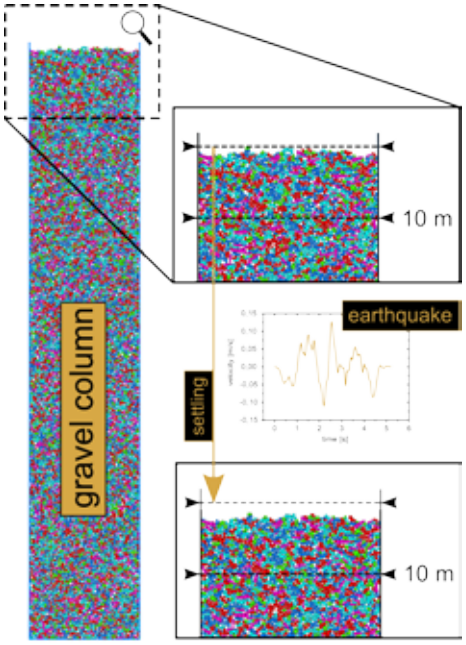
One possible sealing material used for shaft sealing is bitumen or asphalt. Parallel to the tests of TU Freiberg at laboratory scale and in situ, DBE TECHNOLOGY GmbH developed a numerical model to simulate the thermo-mechanical behavior of the material and estimated the conditions during construction of these sealing elements. The general thermo-mechanical behavior of bitumen is known from civil engineering, for instance at road construction. The Burger´s-Model describes the viscoelastic behavior of bitumen. The requirements and the loads related to shaft sealing are very different from common road construction because the main loads on sealing elements are steady, static loads that act over very long periods while dynamic loads are irrelevant. Therefore, the fluid characteristics of bitumen become more important and shear thinning has to be considered, too. The model was calibrated by means of a shear test made with a parallel-plate rheometer. In a first step, common oxidized bitumen was tested at different temperatures. A small wedge of the sample was simulated, and the simulation complied well with most of the tests. There are several differences which result from the fact that shear thinning has not yet been fully implemented in the model.

In a next step, DBE TECHNOLOGY GmbH will start to simulate different sealing elements. But first the thermal impact of the hot bitumen on the claystone and the Excavation Damaged Zone (EDZ) had to be investigated. These simulations consider a layer by layer construction of a huge bitumen sealing element. The resulting stress and changes in stress distribution do not expand the already existing EDZ. But inside the EDZ, the high thermal impact will influence the rock properties.

Impact of earthquakes on geotechnical barriers

In order to prevent that fluids get in contact with the radioactive waste emplaced in an underground repository, the integrity of the geotechnical barriers under different safety-relevant scenarios needs to be demonstrated. One possible safety-relevant scenario is the impact of an earthquake on the geotechnical barrier.

Earthquakes are tectonic movements caused by fracture formations in the earth's crust. The sudden energy release of the fracturing processes generates transient, elastic waves that propagate and can cause massive tremors. Generally, the resulting damages to structures on the surface are larger than to structures underground, where the damage is usually negligible. However, according to current designs, gravel is to be implemented in several sections of shaft seals to act as porous reservoirs and as abutment for bentonite sealing elements installed on top of it. The tremors of an earthquake can further compact the gravel, which leads to a settling of the material, which in turn can compromise its effectiveness as an abutment. For a proper functioning of the bentonite sealing element it is, thus, necessary to limit the settling of the underlying gravel column to appropriately small dimensions.



Model of the gravel column of a shaft seal. Subsidence of gravel level due to settling of gravel caused by an earthquake.

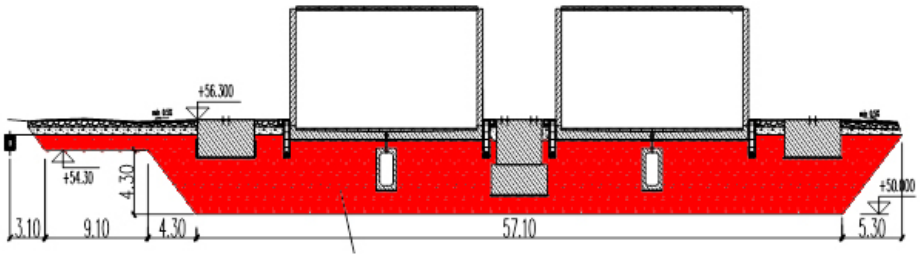
The settling of granular material can be calculated analytically using the silo

Aerial view Kozloduy site (Bulgaria), future repository site marked red (Source: SERAW)

theory, and the additional settling due to the impact of an earthquake can be determined to some extent. However, an analytical assessment has several disadvantages. One aim of the R&D project ELSA (funded by the Project Management Agency Karlsruhe acting on behalf of the Federal Ministry for Economic Affairs and Energy) is to determine to what extent the settling of a gravel column due to an earthquake can be estimated by means of computer codes. This would allow the verification of existing estimates and the evaluation of the suitability of new technical concepts.

Construction planning for the Bulgarian low level and short-lived intermediate level radioactive waste repository

As reported before, a consortium of Westinghouse Spain, the Spanish Waste Management Organisation Enresa and DBE TECHNOLOGY GmbH, supported by the local subcontractor EQE Bulgaria AD, is under contract to the Bulgarian State Enterprise for Radioactive Waste Management (SERAW) for the technical design of a near-surface repository for low level and short-lived intermediate level radioactive waste, the National Disposal Facility (NDF), at the Radiana Site adjacent to the Kozloduy Nuclear Power Plant. A key component of the contracted work scope is the demonstration of the constructability of the NDF. As the construction start of the facility is anticipated for the spring of 2016, the current project work, led by DBE TECHNOLOGY GmbH, focuses on construction planning.



Cross section showing the loess-cement cushion (red signature) - Phase 1 Disposal cell platform of the planned Bulgarian National Disposal Facility

The NDF will be constructed in three phases that are separated from each other by approximately 20 years. Upon completion of the first phase, the NDF will already be fully operational and capable of receiving and disposing of 6,336 waste packages. Phase 2 and phase 3 will increase the available disposal capacity of the NDF by an additional 6,336 waste packages each. After completion of waste disposal, the facility will be decommissioned and a multi-layer engineered barrier will be constructed as a protective cover.

A major initial logistical challenge of construction will be that almost 1 million m³ of soil will have to be excavated and handled before construction work can begin. In order to minimise potential environmental impacts, the excavated soil will remain onsite to the extent possible.

Another challenge results from the requirement that the mechanical soil properties need to be improved for construction. A 5-m-thick loess-cement cushion will be constructed beneath the disposal cells, the Waste Reception and Buffer Storage Building. The cushion beneath the disposal cells also contains embedded structures, including the Infiltration Control Network Galleries as well as the concrete foundation beams for the mobile roofs.

The construction planning accounts for the large volumes of soil to be excavated as well as for ensuring sufficient material supplies, especially large quantities of dry and wet cement, in terms of both quality as well as quantity. Additionally, the plan addresses the contemporaneous construction management of the auxiliary buildings and the disposal cells.

For those of you interested in learning more about this challenging project, additional details on our construction plan for the facility will be presented at the Waste Management Symposium 2016 in Phoenix. We look forward to seeing you there.

For further information visit www.dbe-technology.de or scan the QR code below.

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